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Machine Vision Based Coin Separator and Counter

Prashanna Rangan R.*
Department of Mechatronics Engineering, Kongu Engineering College, Perundurai, Erode, Tamil Nadu, India

Abstract

Automation holds a vital role in nearly all walks of the human life. Separation and counting of Indian currency coins is considered in this project. Nearly all the temples in India have donation boxes (Hundi). More human intervention is required to separate such coins and hence it could be automated and as a result it improves efficiency and reduces the time consumption in the process. This project adapts automation for this time-taking process. It involves the usage of digital image processing technology that aids in detecting the coins and differentiating them; thus, making the process more fast and accurate.

Keywords: *Separation of coins, machine vision, LabVIEW automation, digital image processing, accurate and precise coin estimator*

****Author for Correspondence*** E-mail: prashanna098@gmail.com

INTRODUCTION

Motivation for the Project

In our country, there are more numbers of temples which have a lot of donation boxes. Many people use them and insert coins and currency notes into that as their religious donation. More human intervention is required to separate the currency coins that fell into the currency boxes (*hundi*). This is not reliable for today's fast world. So, we have to take corrective actions against this process. There are some machines available to count the currency notes, but they are not suitable for this purpose. Sorting of coins is a very time consuming and boring job.

The manual method of counting the coins does not have any recording device for future usage. This is not only happening in temples but also in banks which deals with more number of coins and currency every day. Today in our country, there is a need for automation in every field. As well as this time taking process will also need automation. Automation with flexibility provides a good result. This will provide a solution for the process.

There are some machines for sorting and counting the coins, but they need to be operated manually and they are not suitable to assemble inside a donation box. People in temples need to spend more time on separating the coins, which is now not performed by those conventional machines. They become bored getting tired of this continuous work.

Automation provides efficiency and accuracy. It does not need any human intervention. Coins and currencies are separated at the time of insertion of donation itself. Thereby it is reducing the time for separation of coins and currency manually. With the help of a blower, it separates the currencies which are inserted into the donation boxes. Then coins are sorted according to their diameter. Counters are used for the counting purpose. The counted values are displayed on a display for the recording purpose. An electronic controller acts as a brain of this system which controls the sequence of operation. The excellent interfacing of mechanical components with the electronic devices makes this efficient mechatronics system. This reduces the man power and increases the level of accuracy.

Existing Technologies

There are numerous techniques that are used to separate such coins of different denominations. The parameters such as size, weight and material have been used as the parameter to analyze and recognize the denomination of coin. Various programming languages like C, C++, C#, Java, Python etc. are also used.

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Fig. 1: *Manual Counting Method.*

There are some machines available for the counting of coins alone. But they are not suitable for our area of application. These machines also require some man power for their operation. In most places and temples, coins and currencies are separated and counted manually as shown in Figure 1. It is a three-step process, involving firstly the collection of the mixture of coins and currency denominations then segregating them into coins and notes and finally counting them and noting the denominations for future use.

The objective of the work done by Velu *et al*. is to classify recently released Indian coins of different denominations and to count the total value of the coin in terms of Indian National Rupees (INR) [1, 2]. The system combines Robert's edge detection method (93% accuracy), Laplacian of Gaussion edge detection method (94% accuracy), Canny edge detection method (97.5% accuracy) and Multi-Level Counter Propagation Neural Network (ML-CPNN) based approach (99.5% accuracy). Parameters like shape, size, surface, weight etc. are considered and Matlab has been used as a medium for simulation and obtaining the result. The comparison between the existing technologies were discussed briefly by Modi *et al*., especially using image processing techniques and found that the maximum accuracy of 99.7% has been achieved in 1996 for Canadian coins using decision trees [3].

The system proposed by Anija *et al*. used a FPGA (Field Processed Gate Array) controller coupled with MATLAB to detect the currency notes to check for faulty and fraudulent notes [4]. The denominations of the currency are counted by using the Artificial Neural Networks if the notes are genuine. There is a DC gun for sorting process.

The system proposed by Rohan *et al*. made uses of SIFT algorithm in addition with MATLAB tool to detect the coin [5]. It makes use of feature extraction technique to distinguish between the coins. Similarly, Malatesh *et al*. used edge detection algorithm to detect the coins [6].

Demerits of Existing Technologies

The drawbacks of the existing system are that the manual separation consumes more time compared to automatic one. Nowadays labor shortage is one of the biggest problems. Some of the drawbacks are listed below:

1. Human effort required for the whole process.
2. Time consumption is high.
3. Manual method needs individual machines for counting coins and currency.
4. No recording device and displaying unit as in case of manual counting.

The system proposed by Velu *et al*. is only for simulation purpose, as it lacks hardware implementation [1]. The techniques discussed in most of the existing technologies made use of MATLAB as the major tool along with most complex algorithms to detect and classify the coins. It has more complexity to build and it lacked readability at times of false seeking.

PROPOSED SYSTEM

The data like the size of the coins, colour etc. are gathered from the Indian Government website [7]. The methodology used in this model is an embedded system, consisting of a LabVIEW controller, used to control the whole system. It involves the system with a vibrating grill followed by the separating path. The separating path has a digital camera used to capture the image of each and every coin and compares them with the template image and actuates a servo mechanism for segregation process. It involves the use of IR sensors for counting operation of each denomination and has a LCD display as a displaying unit.

Concept of the Project

Separation of coins and currency and counting them is a very time taking process which needs more manpower. The proposed system utilizes the digital image processing template matching algorithm, by which the value of the coin is identified. It also makes use of the edge detection algorithm to detect the edges of the coins and counts them if the coin is turned up-side down. It also matches colour of the coin to segregate coins, as the new 1 rupee and 5 rupee coins are more or less similar in size.

Components

LabVIEW

The LabVIEW stands for Laboratory Virtual Instrumentation and Engineering Workbench. It is a graphical programming type of hardware interface, which can be used merely for all engineering applications with ease of programming interface. It eliminates the need of remembering the terms and instructions of the text-based programming language, as it provides a Graphical User Interface. It eliminates the use of complex algorithms. The user interface of the LabVIEW software is as shown in the Figure 2.

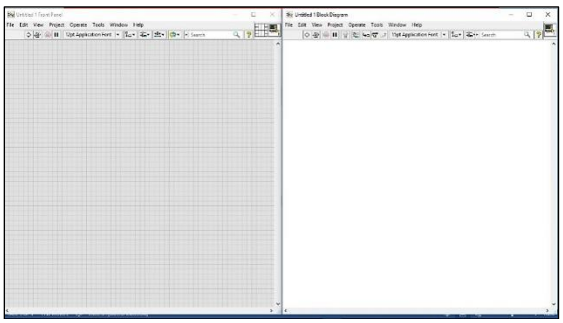

Fig. 2: *LabVIEW UI.*

Digital Camera

The digital camera acts as the eye of the module, enabling the LabVIEW software and the hardware to acquire the image of the coins. It is as shown in Figure 3.

MyRIO 1990

The MyRIO-1990, shown in Figure 4 is a stand-alone hardware, developed by the National Instruments. It works on the LabVIEW platform. As soon as the LabVIEW program gets dumped to the hardware, it starts to work on its own and the controls are taken from its GPIOs. The webcam can be interfaced with it via the USB 2.0 port. It also has Wi-Fi connectivity to transmit the data wirelessly using IoT.

Fig. 3: *Digital Camera.*

Fig. 4: *MyRIO1990.*

IR Sensor

An IR sensor, shown in Figure 5 is a discrete type of sensor, which has an IR transmitter and an IR receiver to detect the presence of objects. When an object is detected, it sends a logic high (5 V) signal at its output. It is used to detect the presence of the coins and to count it.

Fig. 5: *IR Sensor.*

Servo Motor

The DC servo motor, as shown in Figure 6 is a kind of DC motor, which has the capability to stop at any precise angle. It has a feedback node, via which the motor can be controlled and made to stop at the required positions. It has high starting and stall torque. It is used to tilt the edge plate of conveyor to five preset positions to make the coin fall at respective boxes.

Fig. 6: *Servo Motor.*

Working

A coin separator is commonly seen in areas like coin vending machines, placed in public areas. The function of the coin selector is to determine the denomination of coin as well as to forbid any fake or invalid coin, as shown in Figure 3. The operation time to detect each coin is slow in the manual method.

Table 1: *Coin Dimensions.*

S. No.	Denominations (INR)	Dimension (mm)
1.	1 Rupee	22
2.	2 Rupee	23
3.	5 Rupee	25
4.	10 Rupee	25

Fig. 7: *Indian Coins.*

The parameters like dimensions and outlook of old and new coins of different denominations are considered for classification. The coin dimensions are as shown in Table 1 and the images are shown in Figure 7.

Fig. 8: *Top Portion of the Setup.*

The system has a hopper coupled with a vibrator base plate Figure 8 [8]. It consists of a blower arrangement which is used to blow the currency notes, which may be mixed with the coins. There is also a vibrator grill, which is used to make the coins get arranged in a linear pattern and to fall one after the other, which get collected below. There is a screw extruder by which the coins are taken one after the other. It is then made to travel along a conveyor, where a camera detects the physical parameters of each and every coin like dimension, colour, denomination etc. It is further processed using digital image processing technology. Various algorithms like edge detection, template matching, object tracking etc. are implemented and the coins are identified. The identified coin is made to fall in the four containers (for denoms of 1, 2, 5 and 10 INR) as shown in Figure 9. It is made with the aid of a servo motor, which turns the conveyor to the required angle. There are sensors attached to the end terminal of the conveyor to count the coins in each denoms. The counted coins are displayed on a LCD display, by which the value can be acquired.

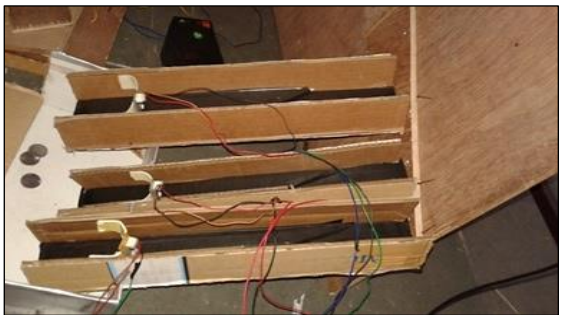

Fig. 9: *Coin Path with IR Setup.*

NI Vision Assistant - Code Generation Target: LabVIEW
File Edit View Image Color Grayscale Binary Machine Vision Identification Tools Help
2 middle.jpg - RGB (32 bits) - 1016x1025
1 of 1
Processing Functions: Image
Histogram: Counts the total number of pixels in each grayscale value and graphs it.
Line Profile: Displays the pixel value distribution along a line of pixels in an image.
Measure: Calculates measurement statistics associated with a region of interest in the image.
3D View: Displays the light intensity in a three-dimensional coordinate system.
Brightness: Alters the brightness, contrast, and gamma of an image.
Set Coordinate System: Builds a coordinate system based on the location and orientation of a reference feature.
Script: Untitled Script 1
Original Image
five rupee
two rupee
one rupee
Help
<< Process Images
Select Controls >>
Finish
Cancel

Fig. 10: *Choosing the Template.*

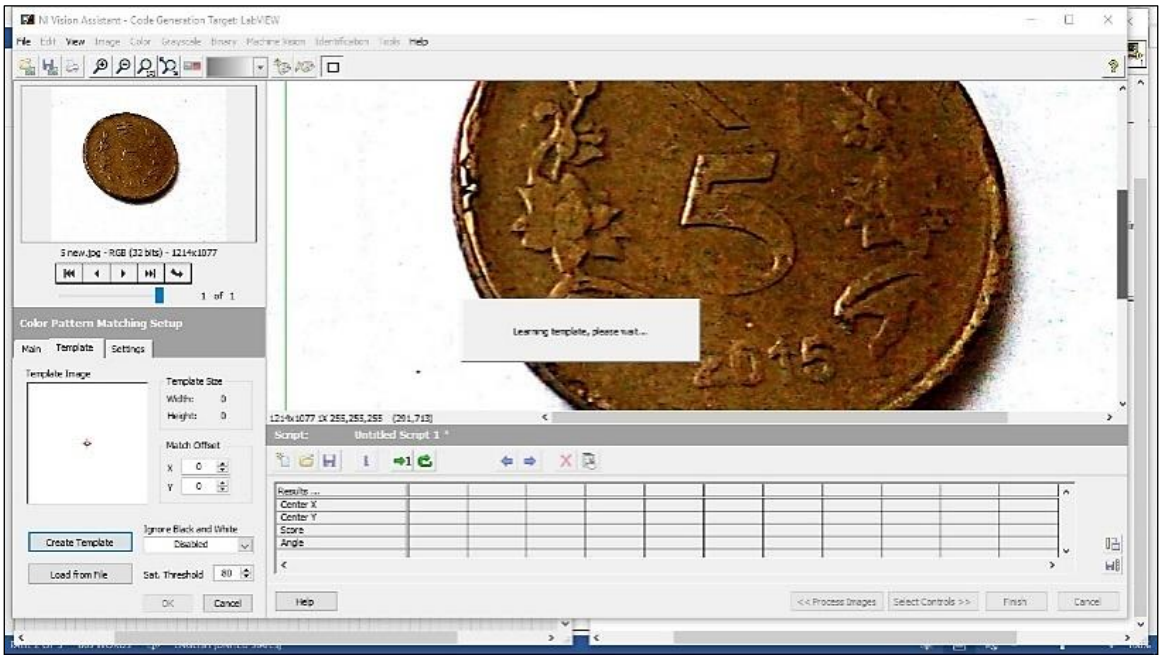

Fig. 11: *Training the Template.*

The template file is first taken as shown in Figure 10 and is trained as shown in Figure 11, is one to make the software realize the coins and increment the values (Figure 12).

There is a fifth box, placed inside the setup, which is used in case of a forgery or invalid coin. If any such coins are detected, it is collected in the box and mentioned on the display.

FEASIBILITY STUDY

This project consists of simple mechanical and electrical components which make the system technically and operationally feasible.

Operational Feasibility

Operation of the entire model can be achieved by using the host controller (myRIO), electrical actuators, sensors, controller circuit and mechanical system. DC motor is used to

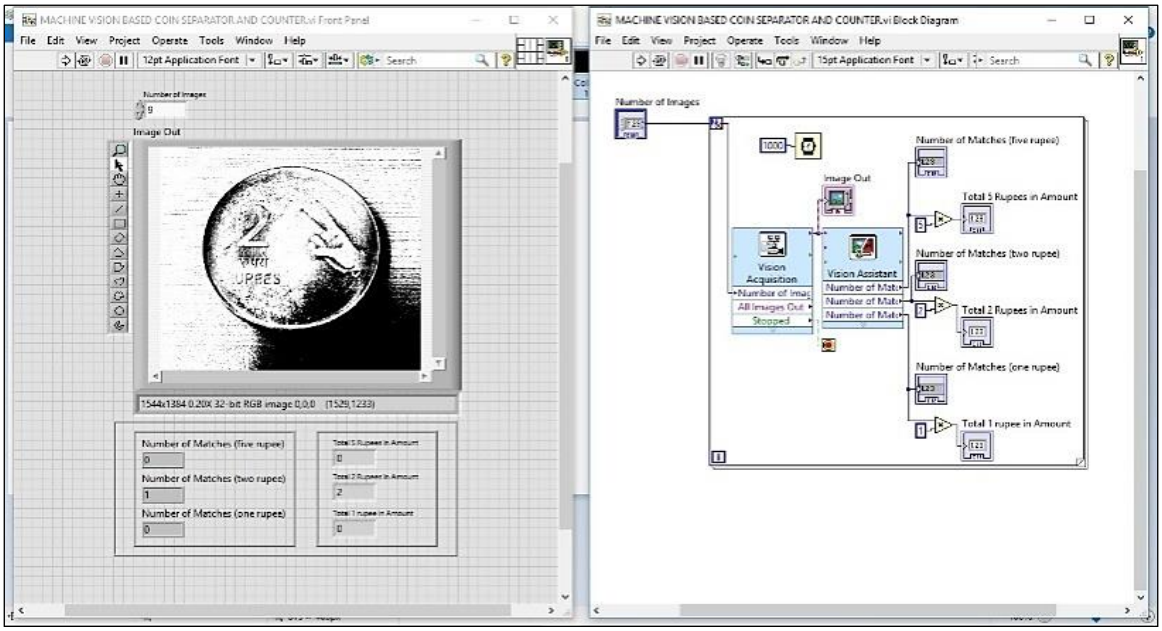
MACHINE VISION BASED COIN SEPARATOR AND COUNTER.vi Front Panel
File Edit View Project Operate Tools Window Help
Number of Images
Image Out
Number of Matches (five rupee)
Number of Matches (two rupee)
Number of Matches (one rupee)
MACHINE VISION BASED COIN SEPARATOR AND COUNTER.vi Block Diagram
Vision Acquisition
Vision Assistant
Total 5 Rupees in Amount
Total 2 Rupees in Amount
Total 1 rupee in Amount

Fig. 12: *Numerical Incremental of Coins.*

vibrate the hopper. Blower is used to separate the currency. IR sensors are used to count the number of coins. The controller gives the sequence of programming for the required operation to be done.

Technical Feasibility

The components required, and the technologies adapted for the project are available in ease. Sufficient technology is available to carry out this project. Globally available software packages fulfil the requirements adapted for developing the project into product. The design which has to be implemented can be simulated through the available software and prototype can be developed according to the concept. After attaining the results of prototype, the concept which has been designed can be fabricated into a product. The proposed system is technically feasible and makes the existing system incompetent.

Economic Feasibility

The cost estimation of the project is about ₹80,000, which is quite high; yet, since it provides high accuracy in segregating the coins, it proves to be economically feasible.

MERITS AND DEMERITS

Merits

- No need for human intervention;
- Less time consumption;
- Low cost automation;
- High operating accuracy; and
- User control and digital display.

Demerits

- It has a one-time huge investment; and
- Sensor failure may lead to faulty computation.

CONCLUSION

Manual method can be completely replaced by this proposed method. Time consumption in counting the coins is much reduced. Proposed model can be used widely in donation boxes and other places like charities, where we have to separate and estimate the coins and currency.

It can be specifically used in temples, where segregation and counting of coins plays a major role and is a vital and mandatory process to carry out.

FUTURE SCOPE

This system can be further developed and improved by making it to function as a currency counter. The proposed model can separate coins and estimate them. In future, it can also be upgraded as a separator for stack of currency. By implementing the currency counting mechanism, it could serve the society efficiently and effectively.

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